

# **TRANSFUND NEW ZEALAND**

## **Post Construction Safety Audits Seal Extensions**

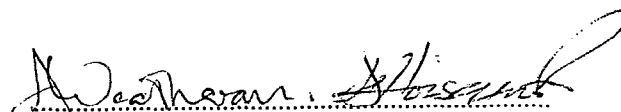
**Review and Audit Division  
Report No. RA97/662S**

**TRANSFUND NEW ZEALAND**


**POST CONSTRUCTION SAFETY AUDITS**

**SEAL EXTENSIONS**

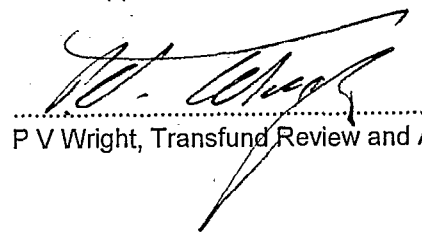
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**OCTOBER 1998**

POST CONSTRUCTION SAFETY AUDITS: SEAL EXTENSIONS  
FINAL REPORT

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POST CONSTRUCTION SAFETY AUDITS  
SEAL EXTENSIONS

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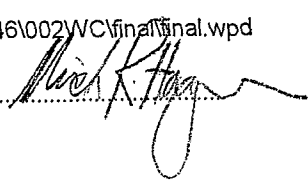
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DISCLAIMER

This is a final report. It has been prepared in the discharge of Transfund New Zealand's legal responsibility to audit the performance of local authorities against regional programmes and District Roothing Programmes/Transit New Zealand against its State Highway Programme.

The findings, opinions and recommendations in the report are based on an examination of a sample only, and may not address all issues existing at the time of the audit. Readers are urged to seek specific advice on particular matters and not rely solely on the report.

While every effort has been made to ensure the accuracy of the report, it is made available strictly on the basis that anyone relying on it does so at his/her own risk without any liability to Transfund New Zealand.

## SECTION 1 : EXECUTIVE SUMMARY

### 1.1 Background

This project was initiated by Transfund New Zealand (Transfund) in 1997 following concerns that safety compromises had been made on some seal extensions.

### 1.2 Brief

The project brief was divided the work into two phases:

The first phase was to prepare an initial scoping report based on a desktop review of approximately 30 seal extension designs and to select approximately 10 projects which raised the most safety concerns for further investigation. The second phase was to undertake site inspections of the projects selected and prepare a final report detailing the full findings of the team.

### 1.3 The Audit

The Scoping Report RA96/560S was prepared in June 1997 and examined the construction documentation of 30 projects. The sites were selected nation wide at random from both Transit and Local Authorities with the criteria that the project must be over 1km long, must cost in excess of \$250,000, must have been constructed in the last 5 years, and no more than 3 to be chosen from each Road Controlling Authority. In this report nine sites were selected for further investigation of which most either lacked adequate seal width, were located in difficult terrain, or had no formal design.

This final report, prepared following inspection of the nine projects selected, details safety concerns identified by the team during both phases of the project and also reviews some of the procedural matters which are of a more technical nature. It is not the intention of this report to focus on the nine specific sites which were inspected but to make comments of a general nature which will provide guidance on what changes could be implemented by Transfund and the Road Controlling Authorities.

The nine Site Safety Inspections were undertaken between November 1997 and March 1998.

#### 1.4 Conclusions

The team had expected that most safety compromises would have been the subject of investigation/debate prior to submission to Transfund for funding assistance. However, both safety and engineering risks appear to have been taken without adequate assessment of downstream costs. Only very serious safety problems appear to have been adequately investigated. Little if any thought appears to have been given to options including sight distance/vertical curve improvements or low cost safety improvements such as appropriate standards of road markings and delineation.

The concerns that inadequate seal width may be a wide spread problem were not realised. It was the engineering compromises made to achieve the appropriate seal width which were of most concern. The only project inspected with a significant length of substandard seal width was in steep rocky terrain and compromises were deemed to be necessary. The greatest safety concern on this project was that the road marking and delineation were almost in total conflict with the RTS5 (1).

It would appear that there is little incentive for Road Controlling Authorities (RCA's) to adequately address low cost safety issues. This applies even to economic evaluations. Where there are no accident costs then there are no benefits to be claimed. When there are accident benefits claimed the savings are derived from addressing the causes of the known accidents. These are in general attributed to either the unsealed surface or sub-standard geometry. There is no evidence of accident costs/benefits being related to the inclusion of low cost safety measures. There is also a serious lack of adherence by Local Authorities to the geometric and safety guidelines contained in the Transfund Standards and Guidelines Manual (TFM1) (2).

It should be noted that some of the conclusions reached also relate to the writers' personal experience in the preparation of project evaluations, designs and safety audits of seal extensions.

#### 1.5 Recommendations

*That Transfund require general adherence to the geometric and safety guidelines contained in the Transfund Standards and Guidelines Manual from all Road Controlling Authorities as a condition of receiving financial assistance.*

*That Transfund require Road Controlling Authorities to provide scheme assessments which demonstrate that low cost safety measures have been considered and where appropriate their costs included in project estimates.*

- (1) LTSA Road and Traffic Standards 'Guidelines for Rural Road Marking and Delineation'
- (2) Transfund Standards and Guidelines Manual

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*That Transfund adopt the other specific recommendations contained within this report.*

**1.6 Team Members**

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Dr Ian Appleton accompanied the team on 7 of the 9 site inspections.

**1.7 Documents Used**

Project documentation as supplied by the relevant Road Controlling Authorities

Scoping Report RA96/560S

Transit New Zealand Manual of Safety Audit Policy and Procedures (August 1993)

Transit New Zealand Standards and Guidelines

Land Transport Safety Authority Standards and Guidelines

## SECTION 2: METHODOLOGY

### 2.1 Brief

The project brief divided the work into two phases: An initial scoping report based on a desktop review of seal extension designs and a final report detailing the safety concerns identified during both the desktop phase and the project inspections.

### 2.2 Stage 1 - Scoping Report

The Scoping Report RA96/560S was prepared in June 1997 and examined the construction documentation of 30 projects.

Seal extension projects were selected nation wide at random from the National Roothing Programme with the criteria that the project must be over 1km long, must cost in excess of \$250,000 and have been completed since 1993.

Only 18 authorities were found with projects meeting these criteria:

- Far North District
- Whangarei District
- Rodney District
- Thames Coromandel District
- Gisborne District
- Central Hawkes Bay District
- Wellington City
- Marlborough District
- Tasman District
- Waimakariri District
- Grey District
- Clutha District
- Queenstown Lakes District
- Waitaki District
- Southland District
- Transit New Zealand (Transit): Auckland, Hamilton, Dunedin

A stratified sample of 30 projects with no more than 3 projects to be chosen from any one RCA (treating Transit as seven regional offices), was then selected. The relevant RCA's were contacted and requested to supply detailed designs for each project. In addition the authorities were asked if design or construction safety audits had been conducted, and if so, to supply copies of these reports.

From this sample nine sites were selected for further investigation of which most either lacked adequate seal width, were in difficult terrain, or had no formal design.



### **2.3 Stage 2 - Final Report**

The nine relevant RCA's were visited by the team and Ian Appleton and discussions held with the Roding Asset Manager covering all stages of the project: feasibility, preliminary design, detailed design and construction. Some procedural matters were also discussed.

An initial overview site inspection was then made with a representative of the RCA to locate issues of concern and obtain additional background information relevant to the project. This was followed by a detailed inspection (similar to a post construction audit) by the team and Ian Appleton and followed by a night time inspection. The nine site inspections were undertaken between November 1997 and March 1998.

Detailed site summaries were prepared and sent to the relevant RCA's for comment. The site summaries and responses from the RCA's were published in a Transfund report RA97/686S.

This report is based on the findings of both the initial desktop design review and the nine subsequent site visits. Comments made are of a general nature and are intended to provide guidance as to what changes could be implemented by Transfund and the RCA's.

### SECTION 3: PROCEDURAL MATTERS

#### 3.1 Transfund Objectives

To allocate resources to achieve a safe and efficient roading system.

To ensure that these objectives are met Transfund is continually undertaking technical and procedural audits. This report is firstly a safety audit but there are inevitably overlaps with technical and procedural matters. This section has been devoted specifically to procedural matters which were raised during the investigations.

#### 3.2 Professional Services Briefs

Most projects reviewed had no professional services brief. This was particularly true of Local Authorities which rely on in-house professional services.

##### ***Recommendation***

*That Transfund require Road Controlling Authorities to adopt procedures which include a professional services brief for the investigation, design and construction phases. At least, the asset manager should formally document the design criteria/cost parameters to be taken into account.*

#### 3.3 Scheme Assessments/Application for funding

Currently, Transfund requires funding submissions to be made on Project Information Sheets (PIS) and to be supported by an economic analysis which complies with the PEM (PFM2) (3).

A significant variation was found in the level of investigations carried out to assess the inputs for economic evaluations. Transit New Zealand (Transit) submissions (State Highway projects) were supported by full scheme assessments which thoroughly investigated all options and costs. Local Authorities, however, provided little if any additional supporting documentation.

In generally, insufficient investigations were carried out by Local Authorities to accurately assess the cost of the proposed works. Project estimates were a rate/km assessment based on the cost of a recent similar project. It appeared unlikely that the estimates adequately allowed for contingencies as required in the PEM, or were adjusted for inflation. **This is thought to be a key factor which has lead to inappropriate safety compromises.**

(3) Transfund Project Evaluation Manual

Once the funding allocation is made the level of expenditure is generally fixed and RCA's are reluctant to apply for additional funds as this raises questions about the reliability of the initial investigations. Consequently, it is necessary to absorb any unforeseen costs by means of reducing standards during the construction phase.

There was also concern that the design standards defined in the PIS are generally typical or desirable and did not identify sections of the project which would not meet these standards. Details of the proposal must be provided in full to allow Transfund to properly consider funding applications.

#### **Recommendation**

*That Transfund require all applications for funding to be supported by a scheme assessment or at the very least a design statement. **This must include details and locations of where the design standards proposed cannot be achieved.** (a list of typical items which should be covered is contained in Appendix B).*

### **3.4 Project Economics and Justification**

#### **3.4.1 General**

A number of concerns relating to the PEM were raised by the RCA's and others identified by the team during the review. These are discussed below.

#### **3.4.2 Options Considered/Project Cost**

The PEM Simplified Procedures state that the analyst needs to consider **all** suitable options and that in most cases an incremental analysis will be required. It is likely for all seal extensions there are at least two options: with and without safety improvements. Use of the Simplified Procedures for seal extensions where the cost of improvements is restricted to no more than 30% of the total project cost require only the worksheets for the chosen option to be submitted. This appears to create an anomaly whereby a Road Controlling Authority can promote a project with a high capital cost but not provide full details of other options considered.

#### **Recommendation**

*That Transfund require submissions based on project evaluations for seal extensions using the Simplified Procedures to include the analysis of all options considered and in particular options with and without safety improvements.*

### 3.4.3 Before and after speed (Travel Time Savings)

The PEM provides default values for seal extension before and after speeds (Appendix 7 - table A7.1). Instances of inappropriate usage of the default tables to generate Travel Time Costs and Vehicle Operating Cost savings were noted. These tables are a guide only and must not be used where obviously not valid.

By definition the design speed should approximate the 85th percentile speed. This appears to conflict with the full procedures methodology for determining travel speed (after) where average travel speeds are related to design speeds.

#### **Recommendations**

*That Transfund require all seal extension funding applications to be supported by a travel time survey (before) and a realistic assessment of travel speeds based on design speeds (after).*

*That Transfund review the PEM Full Procedures methodology for calculating mean speeds from design speeds. The inclusion of the horizontal curve radii in the methodology should be considered.*

### 3.4.4 Accident Analysis

The team were very concerned at the variety of methodologies used to assess accident costs and savings. The following are examples of various approaches encountered:

- where there were no accidents recorded the assumption was made that as there are no existing accident costs then there can be no project benefits from safety improvements. It could equally be assumed that there will be safety disbenefits if safety improvements are not included. For example where increased speeds are predicted due to horizontal curve improvements (or the seal extension itself) and there are no proposed vertical improvements there may be safety disbenefits.
- with no recorded accidents one analysis claimed accident savings based on theoretical before and after accident rates. The Do-Minimum accident costs were assessed at \$1,476,000. Accident savings of \$769,000 were claimed.
- one accident analysis was based on 15 non injury accidents reported by local residents. The accident analysis used accident values for reported accidents rather than unreported and consequently the accidents costs and savings were significantly overstated.

- on projects with recorded accidents the percentage reduction to the accident rate varied significantly from 20% to 50%. One project where there were 2 recorded injury accidents in a five year period was found to have an accident rate of 1.1 times the typical rate. Theoretically, the evaluator could have claimed a 90% reduction to the typical rate. The actual claim was for a 50% reduction.
- another analysis had omitted the speed adjustment factor
- in one evaluation the Do-Minimum included an upgrading capital cost equal to approximately 80% of the project cost (presumably to met safety/design standards).

Overall the team were concerned that as the existing traffic volumes and accident numbers are very low, a single reported accident can equate to a very high accident rate and can be used to generate significant safety benefits while on a project with no reported accidents no benefits can be generated. A recently amendment to the PEM restricts accident analyses based on small numbers of accident numbers. This ignores the fact that one reported accident may theoretically equate to up to 40 non reported accidents and penalises potential projects on roads with low traffic volumes.

### ***Recommendations***

*That Transfund consider requiring an assessment of the disbenefits of not including various types of safety improvements. This may require the development of guidelines to indicate the range of disbenefits to be included.*

*That Transfund review the restrictions on the analysis of small numbers of accidents on roads with low traffic volumes.*

*That Transfund consider producing a methodology to assess nominal accident benefits where traffic volumes are very low and under-reporting very high.*

### **3.4.5 Speed Adjustment Factor (Accident Analysis)**

The PEM provides a calculation for assessing the increased severity of accidents due to the increased speed following construction (Simplified Procedures, Worksheet 7 and Full Procedures, Worksheet A6.3). It is not uncommon for the benefits of a predicted reduction in the accident rate to be negated by the assessed cost of increased severity. Some RCA's considered that it was inappropriate to use this factor for seal extensions.

The team agreed that the speed adjustment factor is too simplistic and does not take into account any additional measures taken to reduce the severity of

future accidents such as guardrails or realignments further away from the top of banks. The newly sealed roadway provides a much better braking surface and combined with the provision of other safety measures is likely to reduce not only the accident rate but in many cases prevent an increase in accident severity.

### **Recommendations**

*That Transfund review the appropriateness of requiring the application of a speed adjustment factor to future accidents for seal extensions. Consider widening the scope of the review to include other work categories and providing further definition as to where a fundamental change may be assumed for accident analysis (Section A6.3.1 PEM).*

#### **3.4.6 Seal Extension Maintenance Costs**

On a significant number of projects the downstream maintenance costs appeared very high and were no doubt well in excess of those assumed in the project economics. This was mainly attributed to following compromises:

- Insufficient survey/preliminary design and inadequate geotechnical investigations at the scheme assessment stage.
- Reducing project costs by designing very steep feather edge slopes which fail to provide adequate edge support. In many cases this will result in continuing high maintenance costs for the life of the project.
- Risking high downstream dropout costs (to constrain project costs) by inadequate setback of the design centre line from unstable banks. On some projects the cost of dropout repairs is likely to exceed that of the seal extension.
- A reluctance to take land.

There is also concern that poor design/engineering is leading to dropouts which may be identified as flood damage/emergency work and applications made to Transfund for financial assistance.

### **Recommendation**

*That Transfund require independent peer reviewers of scheme assessments to **fully** consider the appropriateness of the level of preliminary investigations, geometric design and predicted option maintenance costs in relation to the type of terrain.*

### 3.4.7 Contingency Factors for Project Estimates

In some cases no detailed estimate was available and therefore the team concluded that the project estimate had been based on the cost of a previous similar project. No contingencies or design and supervision costs appeared to have been included.

The standard default contingency values may not be appropriate if there have been insufficient geotechnical/preliminary design investigations. The contingency factors must allow for the risk of unidentified costs associated with various options.

#### **Recommendation**

*That Transfund require Roading Controlling Authorities to provide **detailed** estimates which include design and supervision costs and **appropriate** contingency factors as required by the PEM.*

### 3.4.8 Peer Review

Although all projects appeared to have been subject to a peer review of some form or another (possibly by Transit as it was the fund provider at the time these projects were constructed), the team was concerned that peer reviews seemed to focus on the mathematical accuracy of the project evaluation and not adequately consider other issues relating to design, costs and safety standards.

The procedure by which 'independent' peer reviewers are selected is also of concern. Some Transit Professional Services Contracts allow consultants to select and negotiate fees with a peer reviewer of their own choice. Although the reviewer must be acceptable to Transit the financial link between the two consultants must compromise the true independence of the reviewer.

#### **Recommendations**

*That Transfund ensure peer reviews are carried out by personnel who have a sound knowledge of the design process as well as project economics. Alternatively, Transfund should require 20% of all seal extensions to undergo a design safety audit.*

*That Transfund establish selection criteria for independent peer reviewers.*

### 3.5 Post Construction Safety Audits

Very few of the projects investigated had been subjected to a safety audit. Transit has a policy of carrying out formal safety audits on 20 percent of all projects. The team was concerned that in general Local Authorities do not carry out post construction safety audits either formal or informal.

#### **Recommendation**

*That Transfund consider requiring all seal extensions be subject to an informal post construction safety audit by either the Road Controlling Authority or the professional services consultant.*

*That Transfund consider taking on a policy of formal independent safety audits both at random and of those projects which have attracted negative comments by users. These formal independent audits should target approximately 20% of all seal extensions.*

### 3.6 Standards

#### 3.6.1 General

Transit have in place well defined standards and details of these are provided to their consultants. However, nearly all Local Authorities appear unsure as to what standards they should adopt.

There was also concern that in many cases it appeared that designers did not have a sound knowledge of good design practice or access to experienced designers for advice.

#### 3.6.2 Geometrics

For geometric design standards it was widely accepted that the AUSTROADS(4) was the appropriate standard. However, it should be noted that this publication is a guideline and as such need not be strictly adhered to if sound engineering justification can be provided.

There is currently a conflict between the superelevation formula in the AUSTROADS Guideline and that specified by Transit. Consequently, the designs produced by Transit's consultants differ from those produced by many of the consultants for other RCA's.

(4) AUSTROADS Guideline 'Rural Road Design - Guide to the Geometric Design of Rural Roads'



### 3.6.3 Seal Width

For seal widths there was debate within Local Authorities as to whether AUSTROADS , RTS5 or the NRB Guideline for Rural Roads (5) should be followed.

It was noted that some Local Authorities used the seal widths given in the NRB Guideline for Rural Roads, but ignored the Carriageway Width which is an integral part of the typical cross section providing support for the edge of seal. **This is considered to be a major factor which has contributed to the design of roads with no shoulders and potentially significant downstream maintenance costs.** It should be noted that the NRB Guideline for Rural Roads is not listed in the Transfund Standards and Guidelines Manual.

For extra widening on horizontal curves there was agreement that the additional width should be based on traffic composition rather than the widths suggested in AUSTROADS. That is the extra widening should be designed accommodate the tracking of likely vehicles such as logging trucks and recreational vehicles with trailers. Where sufficient extra widening cannot be provided there must be sufficient sight distance to ensure vehicles can stop safely.

### 3.6.4 Delineation

For delineation standards there was only isolated acceptance of RTS5, with some Local Authorities choosing to define their own standards for their road hierarchy. In some cases these standards were being written into the District Plans. The fact that many Local Authorities are choosing to define their own standards may indicate that parts of RTS5 require revision.

### 3.6.5 Signs

The appropriate standard is the Manual of Traffic Signs and Markings (6). This manual has been generally developed by Transit with input from the LTSA. Transit requires all its consultants to comply with this manual but there is currently no legal requirement for Local Authorities to adhere to the manual.

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(5) National Roads Board 'Guide to Geometric Standards for Rural Roads (1985)'  
(6) Land Transport Safety Authority/Transit 'Manual of Traffic Signs and Markings'.

### **Recommendations**

*That Transfund work with Transit and the Land Transport Safety Authority to develop **one manual of national geometric guidelines** for all roads rather than only state highways.*

*That Transfund require all Road Controlling Authorities to generally adhere to the Manual of Traffic Signs and Markings.*

*That RTS5 be reviewed and where necessary revised to meet current requirements. That Transfund discourage the development of local delineation and line marking standards until a revision of RTS5 is issued. That following the issue of the revised RTS5 Transfund require all Road Controlling Authorities to generally adhere to the RTS5 guideline.*

### **3.7 Contract Documentation**

A number of end result contracts with effectively no plans or design were encountered. This type of contract is not considered appropriate. Generally seal extensions by their nature will require cost/safety compromises and it is essential these are assessed as part of the design process to ensure only appropriate compromises are made. All options/costs/compromises should be assessed at scheme assessment prior to the submission for funding.

Minimum levels of design documentation should be:

- Plans views which provide full details of horizontal curve designs including design speeds and maximum superelevations.
- Longitudinal sections which provide full details of vertical curve design speeds. Even if no vertical improvements are proposed, it is still considered important to include longitudinal sections to allow for checking of safe stopping sight distances (the existing design speeds) and assessing the safety of intersections or access ways. Longitudinal sections should only be omitted if the standard of all the existing vertical alignment is well above the proposed horizontal design standard.
- Typical cross sections and details.
- Cross sections at 15-20m intervals. In tight geometry it may be necessary to provide additional information such as the start and end points of superelevation to ensure adequate control of the superelevation and warp rates during construction. It is not considered appropriate for these to be 'eyed in' by plant operators.

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- Details and locations of safety improvements such as guard railing, sight railing, sight benches.
- Details and locations of existing and additional signage. The specification should also include marker posting requirements.